Development of bimorph X-ray nanofocusing mirrors

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Introduction and Objectives

In recent years, several schemes have been proposed to focus intense X-ray beams into a spot with diameter <10 nm. Various optics such as mirrors, multilayer Laue lenses, and zone plates have been proposed to create nano-focused X-ray beams. Although the principle of X-ray nano-focusing was proven several years ago, routine production still remains a technological challenge. Making such beams available to the general scientific community would greatly enhance many research areas including X-ray imaging, spectroscopy, and nano-diffraction. A joint R&D program between Thales SESO and the Optics Group at Diamond Light Source (DLS) has been established to create a nano-focusing X-ray mirror based on bimorph technology previously developed at Thales SESO [1-3].

Results and Discussion

During the first year of collaboration, a set of concepts and technologies were investigated. Two prototypes were created based on 1st [1, 2] and 2nd [3, 4] generation bimorph mirror technology. The ultrathin 1st generation prototype (150mm long) was polished flat using traditional methods. Sixteen embedded piezo electrodes permit localised correction of polishing defects and for the mirror to be bent to an extremely wide range of curvatures (~30 m concave to ~120m convex). This enables the mirror to be bent to a short radius ellipse optimised for X-ray use at DLS's Test beamline B16 [5]. A novel 2nd generation bimorph prototype was also built. This substrate is substantially thicker and its optical surface was pre-shaped to a given ellipse using traditional polishing and ion beam figuring. A number of polishing techniques were combined at different stages of mirror fabrication. In both cases, a set of wavefront sensing methods and metrology instruments were used to assist development of these two technologies [6].

Conclusions

Two mirror prototypes, based on 1st and 2nd generation bimorph technology, have been created. Their dynamic behaviour has been characterised using X-rays and traditional visible light instruments including interferometers and the Diamond-NOM slope profilometer. Advantages and shortcomings inherent to both technologies, as well as focusing results, will be discussed during this contribution.

References

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